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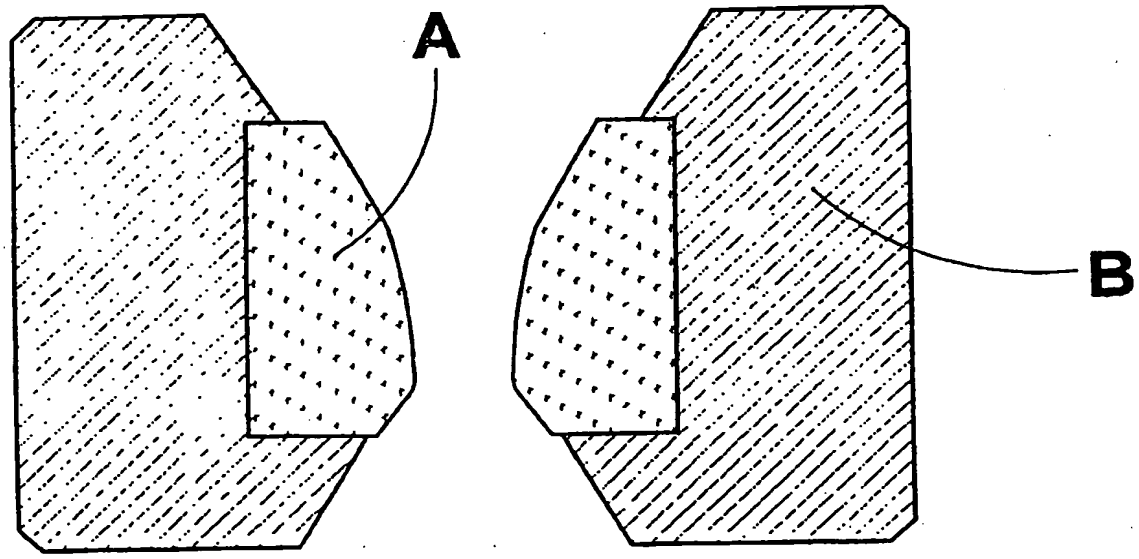
(54) Title: TOOL FOR COLDFORMING OPERATIONS




(57) Abstract: The present invention relates to cemented carbide tools for coldforming and drawing operations. The cemented carbide comprises WC with an average grain of <1 µm and 0.5-4 weight-% binder phase consisting of Co and Ni, <0.5 wt-% Mo, <1 wt-% grain growth inhibitors V and/or Cr. The weight ratio Co:(Co+Ni) is 0.25-0.75 and the structure contains 1-5 vol-% of finely distributed eta phase with a size <5 µm.

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# Tool for coldforming operations

The present invention relates to a tool for coldforming and drawing operations.

Cemented carbide products are used in tools for different coldforming or drawing operations of materials like; steels, copper alloys, composite materials etc. Examples of such tools are wire drawing dies, which consist of a cemented carbide nib shrink fit into a metallic holder. Such tools should have a hard and wear resistant body which also should have the following additional properties:

- good thermal conductivity
- low coefficient of friction (i.e. it may be self-lubricating or assist lubrication with a coolant)
- good corrosion resistance
- resistance to micro cracking and
- high hardness.

When using cemented carbides in tools for the drawing of e.g. steel or other metallic alloys, chemical reactions might occur between the binder metal of the cemented carbide and the metallic alloy. In order to minimise the effects of chemical wear of the binder phase and to improve the wear resistance, a cobalt (binder) content of about 3 % and a WC grain size <1 µm is used in hard metals for such applications. Often a low carbon content close to eta phase formation is chosen. In order to maintain the fine grain size, grain growth inhibitors are used such as VC, $Cr_3C_2$ etc.

US 5,948,523 discloses coldforming tool with an improved hard wearing surface zone. This has been achieved by a post-sintering heat treatment in a boron nitride containing environment of a hard metal of a suitable composition. The effect is most pronounced when the heat treatment is made of a hard metal which has previously

been sintered to achieve a high carbon content through a suitable choice of chemical composition and processing conditions.

It is an object of the present invention to provide a tool for coldforming and drawing operations with a further improved combination of high wear resistance, thermal conductivity, corrosion resistance keeping a good toughness.

Fig 1 shows a drawing die in which A = cemented carbide nib and B = steel casing.

Fig 2 shows in x1500 magnification the microstructure of a cemented carbide according to the present invention etched in Murakami. The fine distributed black phase is eta-phase

It has now surprisingly been found that a tool for coldforming and drawing operations with a better performance than prior art tools can be obtained if the tool is made of a cemented carbide comprising WC with an average grain of <1 µm preferably <0.7 µm and 0.5-4 weight-% binder phase consisting of Co and Ni, <0.5 wt-% Mo, <1 wt-% grain growth inhibitors V and/or Cr. The weight ratio Co:(Co+Ni) shall be 0.25-0.75, preferably 0.4-0.6. The structure contains 1-5 vol-% of finely distributed eta phase with a size <5 µm.

One preferred embodiment contains 2.5-3.5 wt-% binder phase and 0.15-0.25 wt-% Mo and <0.7 wt-% grain growth inhibitors.

Another preferred embodiment contains 1.4-1.7 wt-% binder phase and 0.05-0.15 wt-% Mo and <0.4 wt-% grain growth inhibitors.

The cemented carbide is made by conventional powder metallurgical techniques such as milling, pressing and sintering. The carbon content is adjusted by adding W-powder to obtain the desired amount of eta-phase.

The invention also relates to the use of the cemented carbide according to the invention for coldforming operations such as drawing and canning.

Example 1

Steel wire-drawing dies with inner diameters between 0.2 and 1.3 mm and external diameter between 6 and 11.5 mm according to Fig 1 were manufactured according to the following:

A WC-3%Co, submicron grain size, VC as grain growth inhibitor, prior art

B WC-1.5 wt-% Co+1.5 wt-% Ni, 0.2 wt-% Mo, 0.5 wt-% $Cr_3C_2$ 0.1 wt-% VC, 0.4 wt-% W with average WC grain size 0.6 µm, see Fig 2.

C WC-0.75 wt-% Co+0.75 wt-% Ni, 0.1 wt-% Mo, 0.25 wt-% $Cr_3C_2$ 0.05 wt-% VC, 0.4 wt-% W with average WC grain size 0.6 µm.

The tools were tested in the wire drawing of brass coated steel wires with high tensile stresses for tire applications with the following results. Performance factor relates to the quantity of product (wire) as length of mass drawn through the different nibs relative to the prior art nib, A.

| | Performance factor |
|---|---|
| A, prior art | 1 |
| B, invention | 3 |
| C, invention | 2.5 |

Example 2

Example 1 was repeated with dies corresponding to A and B under the following conditions.

Dies:

-External diam. 24 x 7 mm.

-External diam. 7 x 4 mm.

-Incoming diam. 0.235 mm

-Internal profile $2\alpha = 10^{\circ}$

-Bearing =0.035 mm

-Steel of the wire: AISI 1005. Initially has a resistance of 36 kg/mm$^2$ but at this latest step its resistance is around 80 kg/mm$^2$.

-Drawing speed: 25 m/s (very high speed, is around 60 % higher than the standard one for this type of drawing).

The following results were obtained:

Wear (µm/hour):

| | |
|---|---|
| A Prior art | 0.39 µm/h |
| B According to the invention | 0.10 µm/h |

Thus, dies according to the invention performed four times better than those according to prior art.

Claims

1. Cemented carbide tool for coldforming and drawing operations c h a r a c h t e r i z e d in comprising WC with an average grain of <1 µm, preferably <0.7 µm, and 0.5-4 weight-% binder phase consisting of Co and Ni, <0.5 wt-% Mo, <1 wt-% grain growth inhibitors V and/or Cr the weight ratio Co:(Co+Ni) being 0.25-0.75, preferably 0.4-0.6 and the structure containing 1-5 vol-% of finely distributed eta phase with a size <5 µm.

2. Cemented carbide tool according to claim 1 c h a r a c t e r i s e d in containing 2.5-3.5 wt-% binder phase, 0.15-0.25 wt-% Mo and <0.7 wt-% grain growth inhibitors.

3. Cemented carbide tool according to claim 1 c h a r a c t e r i s e d in containing 1.4-1.7 wt-% binder phase, 0.05-0.15 wt-% Mo and <0.4 wt-% grain growth inhibitors.

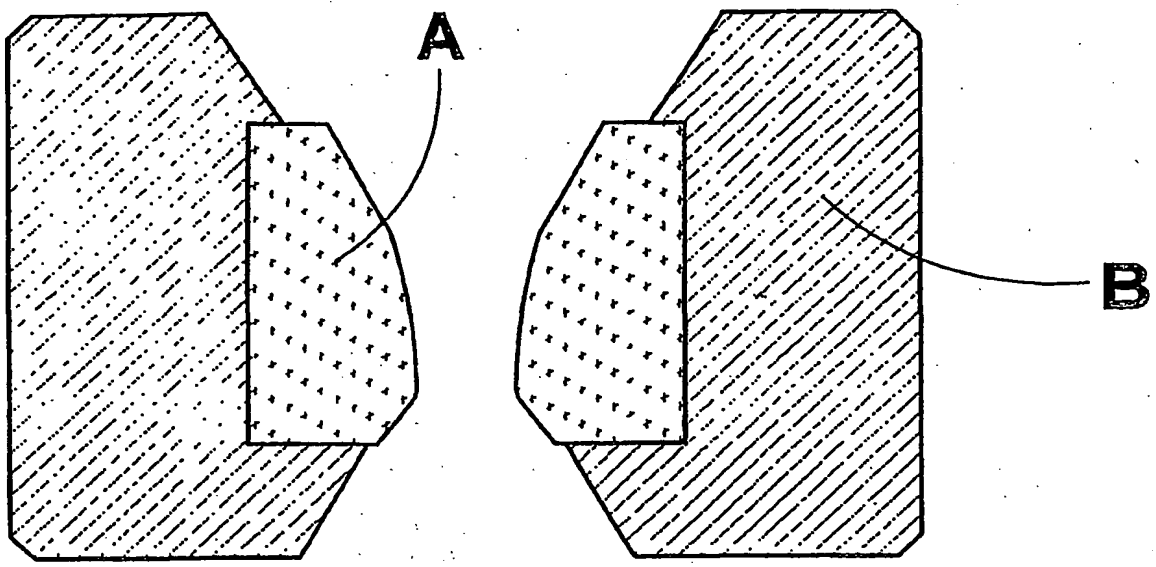


Fig. 1

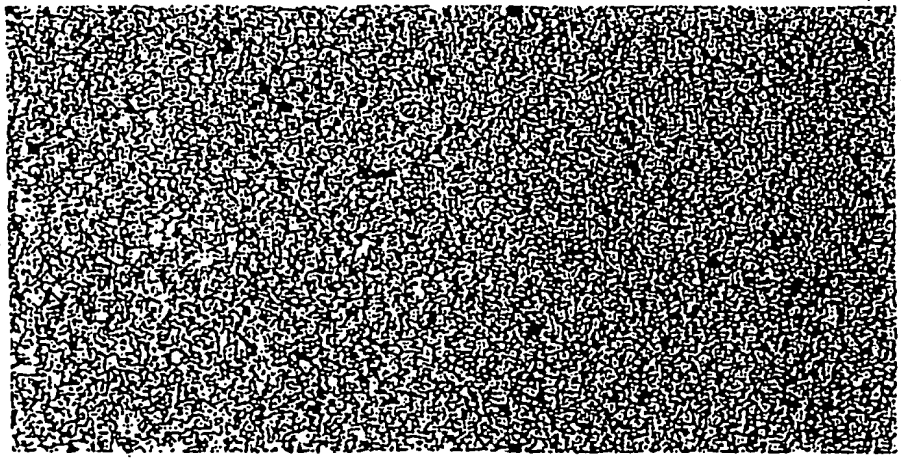

Fig. 2

# INTERNATIONAL SEARCH REPORT

International application No.
PCT/SE 01/02073

A. CLASSIFICATION OF SUBJECT MATTER

IPC7: C22C 29/08
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC7: C22C

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

SE,DK,FI,NO classes as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

WPI, PAJ, EPO INTERNAL

C. DOCUMENTS CONSIDERED TO BE RELEVANT

| Category* | Citation of document, with indication, where appropriate, of the relevant passages | Relevant to claim No. |
|---|---|---|
| A | US 5948523 A (MICHAEL JOHN CARPENTER ET AL), 7 Sept 1999 (07.09.99) -- | 1-3 |
| A | Patent Abstracts of Japan, Abstract of JP 10298698 A (SUMITOMO ELECTRIC IND LTD) 10 November 1998 (10.11.98) -- | 1-3 |
| A | Patent Abstracts of Japan, Abstract of JP 04210447 A (KOBE STEEL LTD) 31 July 1992 (31.07.92) -- | 1-3 |

☐ Further documents are listed in the continuation of Box C. ☒ See patent family annex.

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
"E" earlier application or patent but published on or after the international filing date
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed
"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance: the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance: the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

| Date of the actual completion of the international search | Date of mailing of the international search report |
|---|---|
| 3 January 2002 | 21-01-2002 |
| Name and mailing address of the ISA/<br>Swedish Patent Office<br>Box 5055, S-102 42 STOCKHOLM<br>Facsimile No. +46 8 666 02 86 | Authorized officer<br>Nils Engnell/MP<br>Telephone No. +46 8 782 25 00 |

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# INTERNATIONAL SEARCH REPORT

Information relating to patent family members

International application No.
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| Patent document cited in search report | Publication date | Patent family member(s) | Publication date |
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| | | SE 9602814 A | 20/01/98 |
| | | WO 9803689 A | 29/01/98 |